

OFFICE MEMO

TO: Paul Hutton	DATE: November 19, 2001
FROM: Bob Suits	SUBJECT: Boundary DOC and UVA for DSM2 Planning Studies

Dissolved organic carbon (DOC) and ultraviolet absorbance (UVA) have been developed for the Sacramento River at Greens Landing, the San Joaquin River at Vernalis, and the Mokelumne River at I-5 for the 1975 - 1991 planning simulation period. This memo presents these data and details the methodology used.

General Methodology

The averaged observed DOC from June through October DOC (approximately from 1987 through 1998) was assigned as monthly DOC for the same months over the planning period. In order to generate DOC for the remaining months, relationships between observed DOC and flow were established and then applied to the historic flows over the planning period.

Relationships between DOC and flow were found by first partitioning observed DOC into 3 or 4 categories according to the ratio of observed DOC to historic flow. The categories were presented as containing data exhibiting "low", "moderate", or "high" DOC response to flow. Regressions were then found between DOC and flow for each category of data. Historic patterns of DOC/Flow values were then examined to determine the conditions under which low, moderate, or high DOC response to flow occurred in the past. General trends in the historic data were used to assign each month in the planning period with low, moderate, or high DOC/Flow values. Each month then was assigned a constant DOC (for June through October) or a regression was applied to the flow to obtain DOC. Finally, any generated DOC was limited to falling within minimum and maximum observed DOC at that location.

UVA over the planning period was generated at the three sites by applying regressions between historic UVA and DOC to the generated DOC.

Historic DOC and UVA was available from once or twice-per-month grab samples collected over the approximate period of 1987 through 1998 by MWQI. DOC and UVA in the American River were used as a surrogate for the Mokelumne River. Multiple values of DOC or UVA in any given month were averaged together to yield one value per month. Monthly average flows in the Sacramento, San Joaquin, and American rivers were determined from DAYFLOW.

Greens Landing DOC and UVA

Figure 1 shows historic DOC and flow in the Sacramento River at Greens Landing. DOC from June through October was averaged to yield a single value of 1.81 mg/L to approximate monthly DOC from June through October for the planning period (Figure 2). DOC in other months exhibited a pattern of high values associated with the first large flows of the fall/winter and low values after sustained high flows. Figure 3 and Table 1 show that, after excluding the June-October data, partitioning DOC according to DOC/flow ratio, yielded reasonable regressions between DOC and flow.

Historic flows at Greens Landing were then described as being associated with "low," "intermediate," or "high" DOC response (Figure 4). Observed patterns of DOC response to flow were applied to the planning period by considering current and preceding flows. This allowed each monthly flow during the planning period to be associated with either 1.81 mg/L DOC (June - October), or with one of three regressions with DOC (Figure 5).

After assigning a DOC of 1.81 mg/L to each month from June through October, appropriate regressions were applied to average flows from other months to generate monthly DOC. DOC derived from the regressions was limited to between 1.5 and 5.5 mg/L, the minimum and maximum values seen in the observed data. Figure 6 compares the historic DOC to the DOC generated by this method. Figure 7 and Table 2 show the resulting DOC over the planning period. Peak DOC occurred periodically when flow first increased in the fall or winter after several months of relatively low flow. The average DOC generated at Greens Landing by this process over the planning period was similar to the average observed DOC (Figure 8).

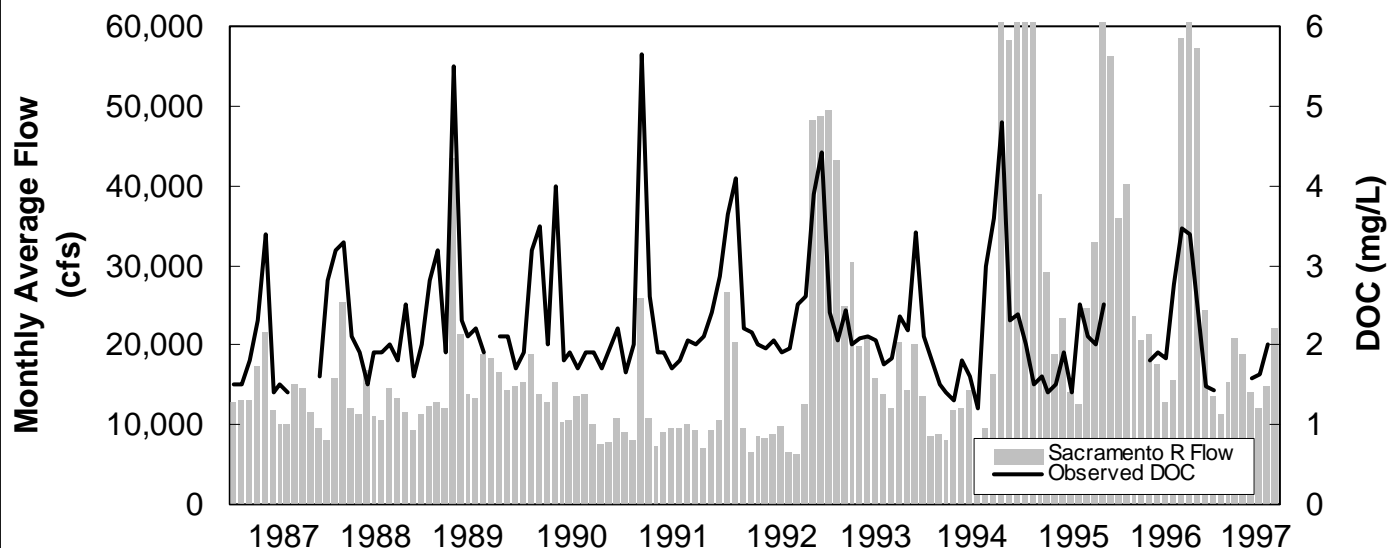
UVA at Greens Landing was generated by applying a regression based on observed DOC and UVA at Greens Landing (Figure 9) to the generated DOC (Table 2).

$$UVA = 0.039DOC - 0.03, R^2 = 0.8$$

Where UVA is in units of Abs/cm and DOC is in mg/L.

Average generated UVA at Greens Landing over the planning period was consistent with the average observed UVA at Greens Landing (Figure 10).

Figure 1. Observed DOC and Flow at Greens Landing



**Figure 2. Observed DOC at Greens Landing, 1987 - 1997
(grouped by month)**

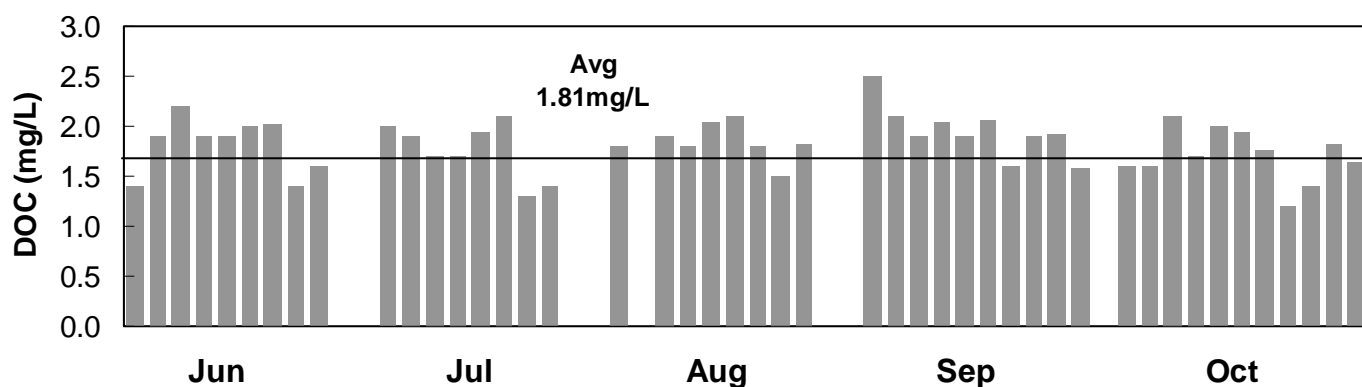


Table 1. Classification of DOC Response to Flow at Greens Landing

DOC Response to Flow	Criteria	Regression Equation	R2
Low	$7.5E-05 > \text{DOC}/\text{FLOW}$	$\text{DOC} = 2.0E-05(\text{FLOW}) + 1.8$	0.3
Moderate	$20E-05 > \text{DOC}/\text{FLOW} > 7.5E-05$	$\text{DOC} = 7.0E-05(\text{FLOW}) + 1.0$	0.8
High	$\text{DOC}/\text{FLOW} > 20E-05$	$\text{DOC} = 17.5E-05(\text{FLOW}) + 0.8$	0.9

DOC: monthly dissolved organic carbon (mg/L)

FLOW: monthly average flow in Sacramento River at Sacramento (cfs)

**Figure 3. Observed DOC at Greens Landing Grouped by Response to Flow
(June - October Values Removed)**

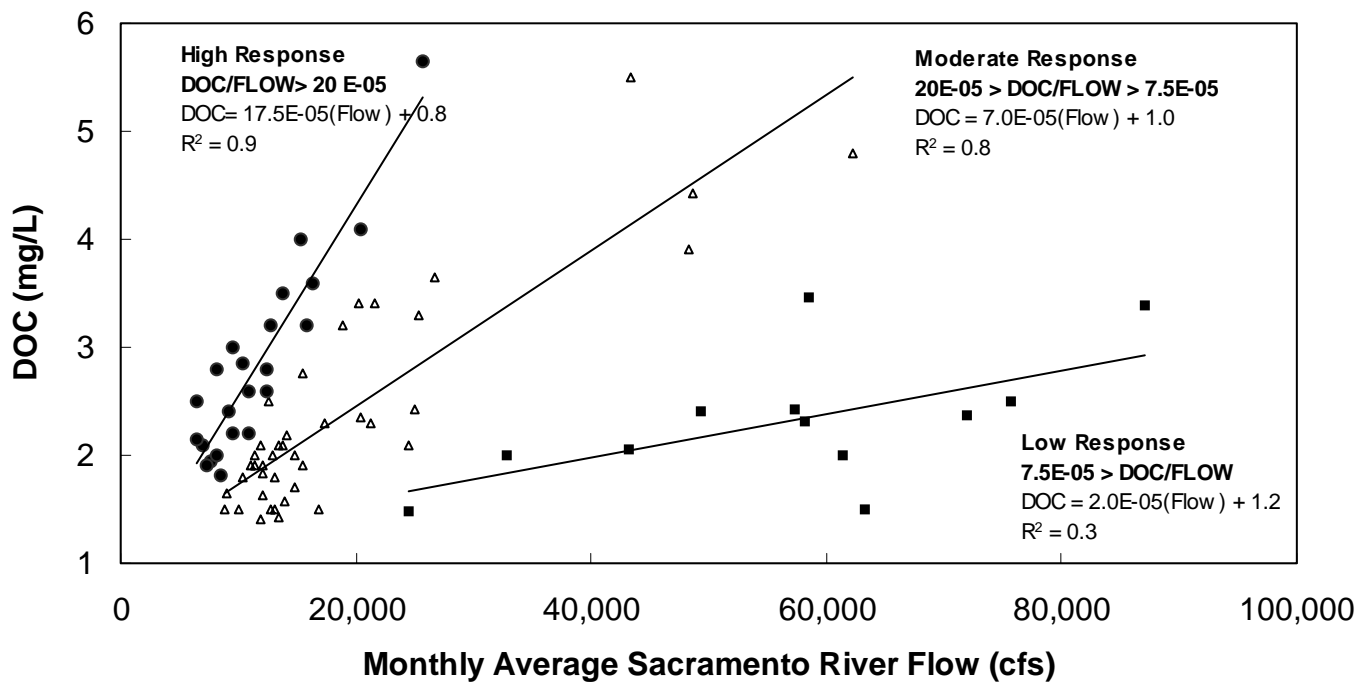


Figure 4. Observed DOC and Response to Flow at Greens Landing

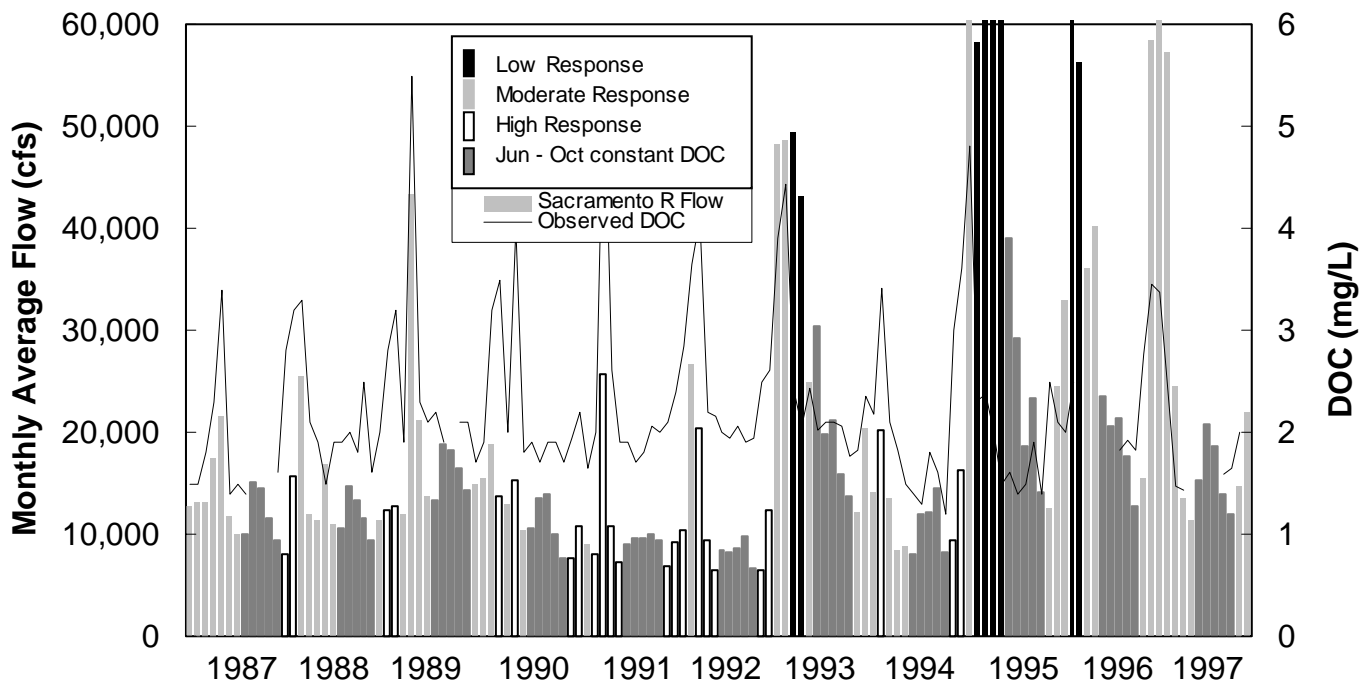


Figure 5. Assignment of DOC/Flow Relationship at Greens Landing for Planning Period

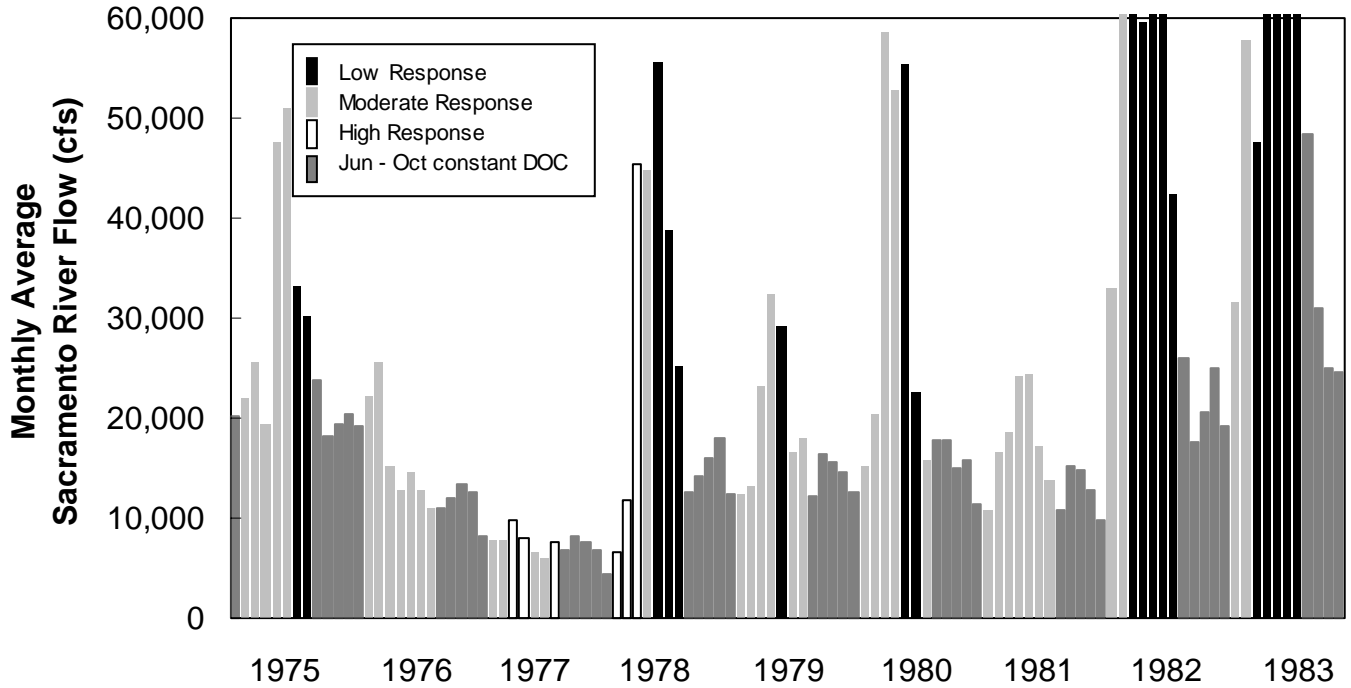


Figure 5. Assignment of DOC/Flow Relationship at Greens Landing for Planning Period

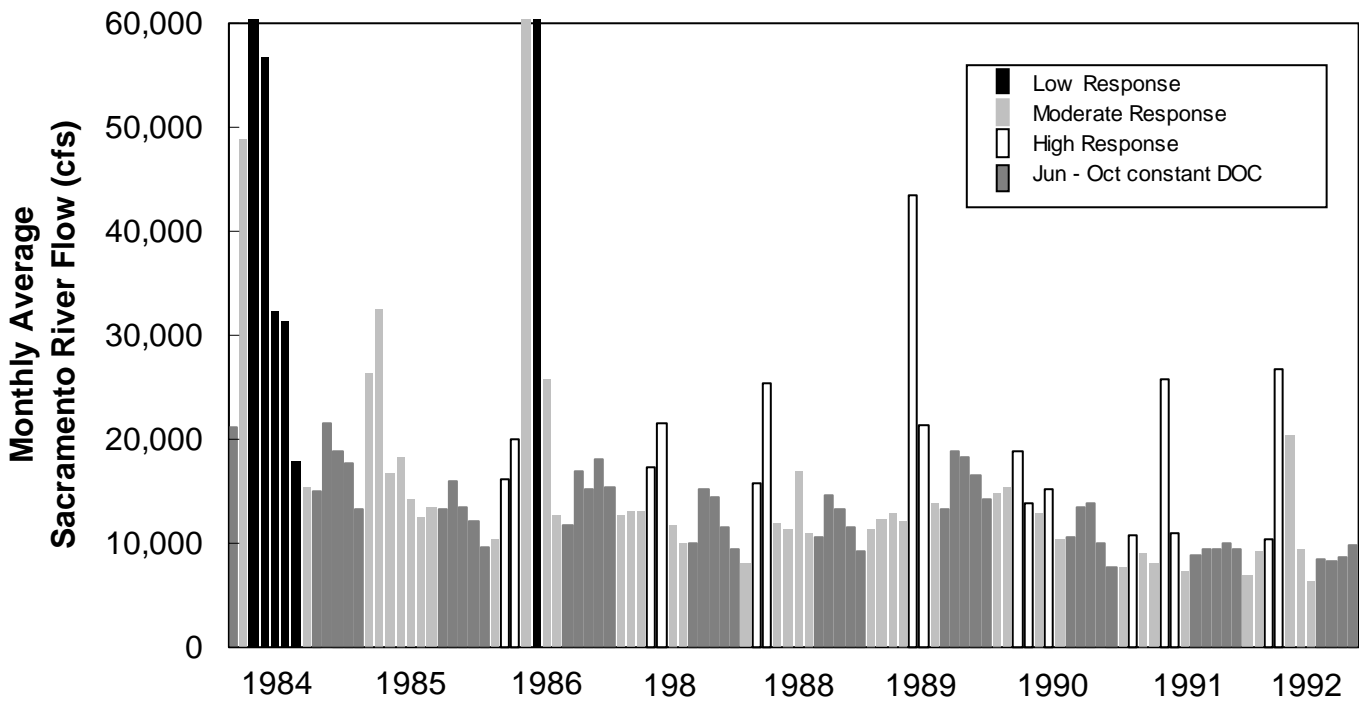


Figure 6. Observed and Generated DOC at Greens Landing

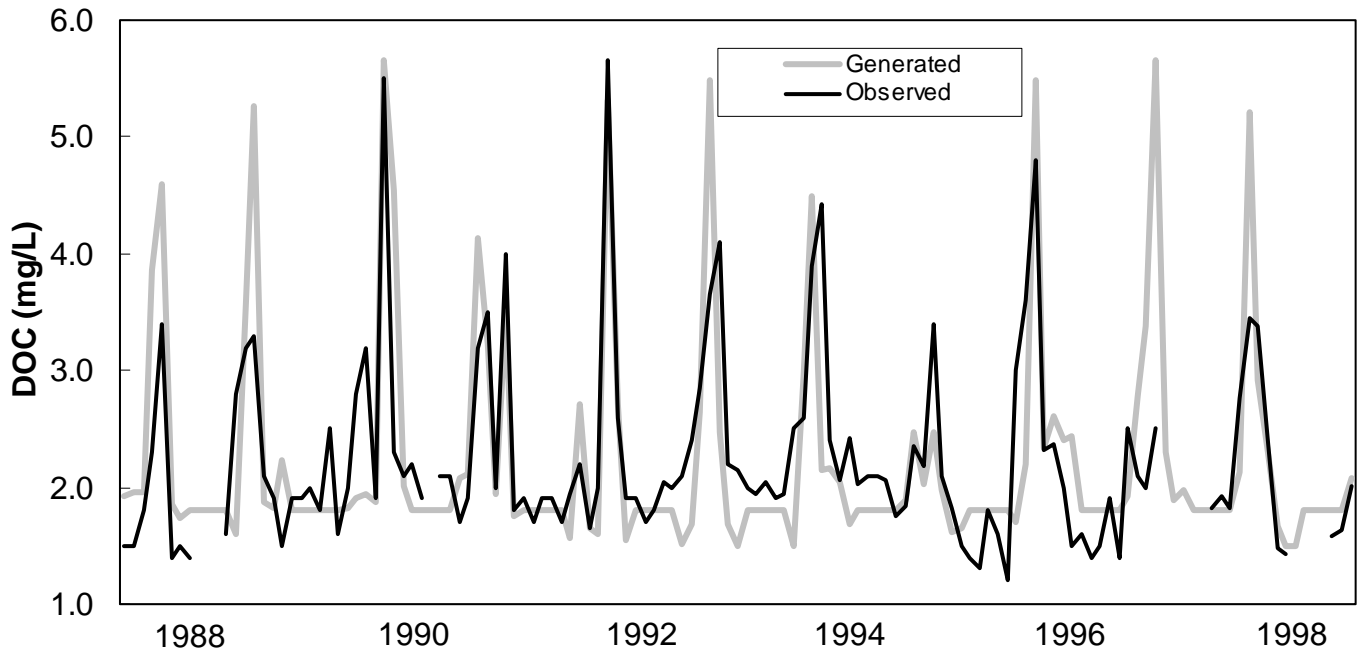


Figure 7. Generated DOC at Greens Landing

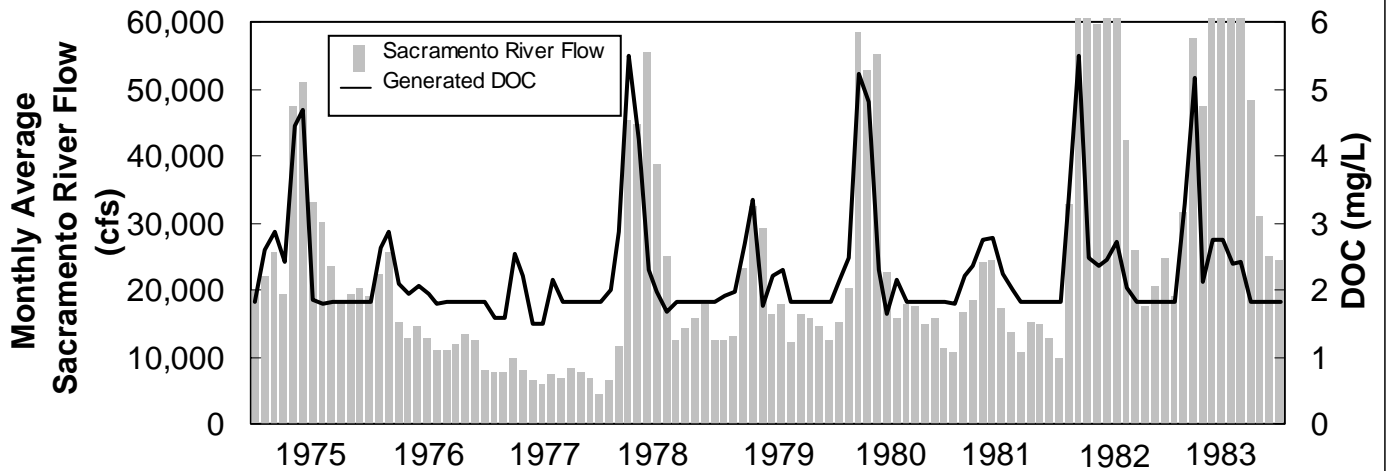


Figure 7. Generated DOC at Greens Landing

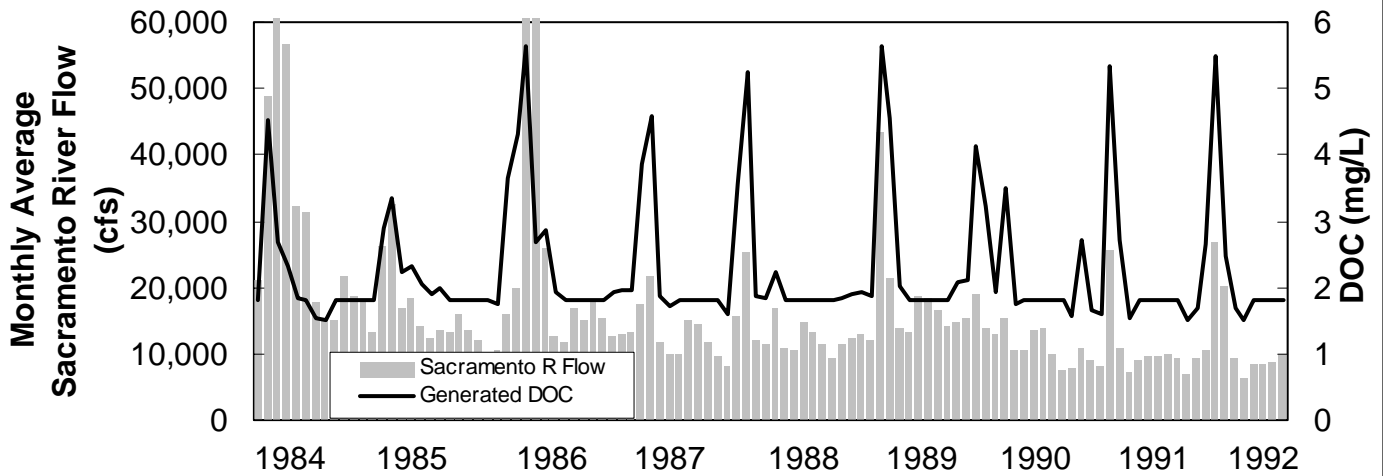


Table 2. Generated Monthly DOC at Greens Landing (values in mg/L)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	1.81	2.60	2.86	2.41	4.43	4.68	1.84	1.78	1.81	1.81	1.81	1.81
1976	1.81	2.61	2.85	2.10	1.93	2.06	1.93	1.80	1.81	1.81	1.81	1.81
1977	1.81	1.58	1.57	2.53	2.22	1.50	1.50	2.15	1.81	1.81	1.81	1.81
1978	1.81	1.99	2.87	5.50	4.23	2.29	1.96	1.68	1.81	1.81	1.81	1.81
1979	1.81	1.91	1.96	2.68	3.35	1.76	2.20	2.31	1.81	1.81	1.81	1.81
1980	1.81	2.11	2.47	5.23	4.82	2.28	1.63	2.16	1.81	1.81	1.81	1.81
1981	1.81	1.80	2.21	2.34	2.76	2.78	2.25	2.00	1.81	1.81	1.81	1.81
1982	1.81	3.38	5.50	2.47	2.37	2.43	2.71	2.03	1.81	1.81	1.81	1.81
1983	1.81	3.28	5.17	2.13	2.76	2.74	2.39	2.42	1.81	1.81	1.81	1.81
1984	1.81	4.53	2.69	2.31	1.83	1.81	1.54	1.50	1.81	1.81	1.81	1.81
1985	1.81	2.90	3.36	2.22	2.33	2.04	1.91	1.98	1.81	1.81	1.81	1.81
1986	1.81	1.76	3.64	4.31	5.65	2.68	2.87	1.93	1.81	1.81	1.81	1.81
1987	1.81	1.92	1.96	1.96	3.86	4.59	1.86	1.73	1.81	1.81	1.81	1.81
1988	1.81	1.60	3.57	5.26	1.87	1.83	2.23	1.80	1.81	1.81	1.81	1.81
1989	1.81	1.83	1.90	1.94	1.88	5.65	4.54	2.01	1.81	1.81	1.81	1.81
1990	1.81	2.08	2.12	4.13	3.23	1.94	3.49	1.76	1.81	1.81	1.81	1.81
1991	1.81	1.57	2.71	1.66	1.60	5.32	2.72	1.54	1.81	1.81	1.81	1.81
Avg	1.81	2.32	2.91	3.01	3.01	2.85	2.33	1.92	1.81	1.81	1.81	1.81

Figure 8. Monthly Average Observed and Generated DOC at Greens Landing

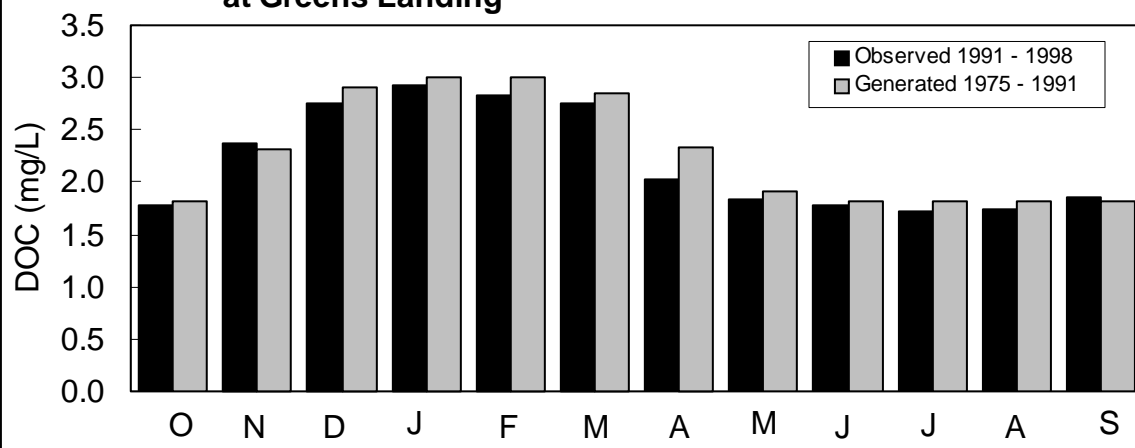


Figure 9. Observed UVA vs Observed DOC at Greens Landing

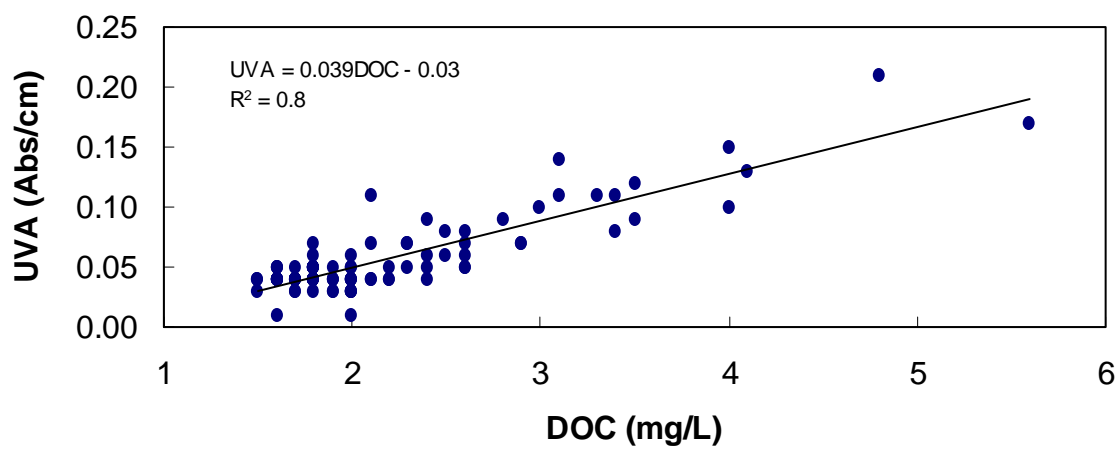
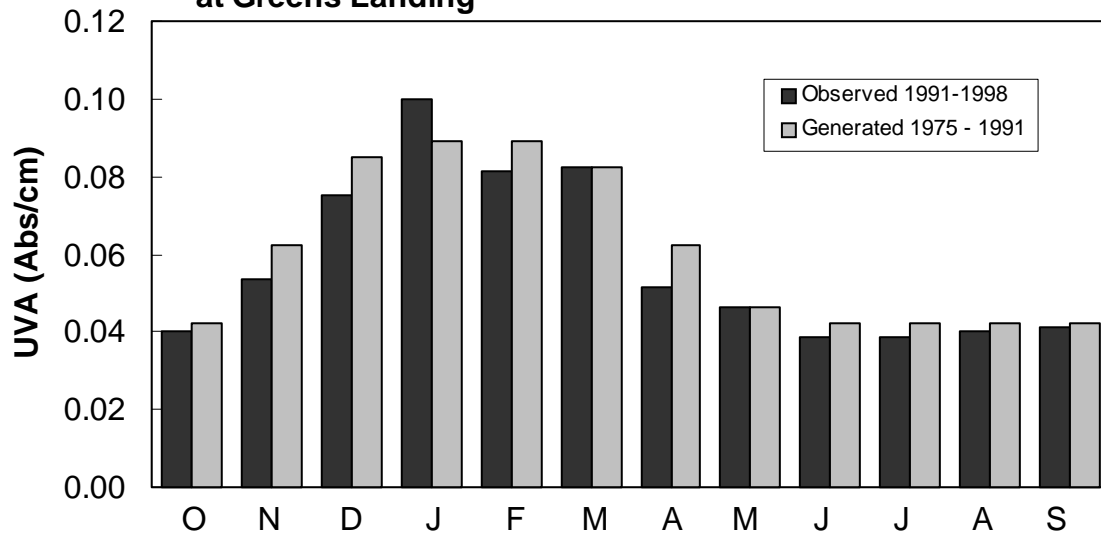


Table 3. Generated Monthly UVA at Greens Landing (values in Abs/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	0.04	0.07	0.08	0.07	0.14	0.15	0.04	0.04	0.04	0.04	0.04	0.04
1976	0.04	0.07	0.08	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04
1977	0.04	0.03	0.03	0.07	0.06	0.03	0.03	0.06	0.04	0.04	0.04	0.04
1978	0.04	0.05	0.08	0.19	0.14	0.06	0.05	0.04	0.04	0.04	0.04	0.04
1979	0.04	0.05	0.05	0.08	0.10	0.04	0.06	0.06	0.04	0.04	0.04	0.04
1980	0.04	0.05	0.07	0.18	0.16	0.06	0.04	0.06	0.04	0.04	0.04	0.04
1981	0.04	0.04	0.06	0.06	0.08	0.08	0.06	0.05	0.04	0.04	0.04	0.04
1982	0.04	0.10	0.19	0.07	0.06	0.07	0.08	0.05	0.04	0.04	0.04	0.04
1983	0.04	0.10	0.17	0.05	0.08	0.08	0.06	0.07	0.04	0.04	0.04	0.04
1984	0.04	0.15	0.08	0.06	0.04	0.04	0.03	0.03	0.04	0.04	0.04	0.04
1985	0.04	0.08	0.10	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.04
1986	0.04	0.04	0.11	0.14	0.19	0.08	0.08	0.05	0.04	0.04	0.04	0.04
1987	0.04	0.05	0.05	0.05	0.12	0.15	0.04	0.04	0.04	0.04	0.04	0.04
1988	0.04	0.03	0.11	0.18	0.04	0.04	0.06	0.04	0.04	0.04	0.04	0.04
1989	0.04	0.04	0.05	0.05	0.04	0.19	0.15	0.05	0.04	0.04	0.04	0.04
1990	0.04	0.05	0.05	0.13	0.10	0.05	0.11	0.04	0.04	0.04	0.04	0.04
1991	0.04	0.03	0.08	0.04	0.03	0.18	0.08	0.03	0.04	0.04	0.04	0.04
Avg	0.04	0.06	0.08	0.09	0.09	0.08	0.06	0.05	0.04	0.04	0.04	0.04

Figure 10. Monthly Average Observed and Generated UVA at Greens Landing

Vernalis DOC and UVA

The method of generating DOC and UVA at Vernalis was similar to that described for Greens Landing. Figure 11 shows historic DOC and flow in the San Joaquin River at Vernalis. DOC from Mossdale was used if available during times when Vernalis data was missing. Average observed DOC from June through October, 3.83 mg/L, approximated monthly DOC over this interval for the planning period (Figure 12). DOC from other months again exhibited a pattern of high values associated with the first large flows of the fall/winter and low values after sustained high flows. The Vernalis/Mossdale DOC was partitioned according to DOC / Flow values into four classifications, labeled "low", moderate-low", "moderate-high", or "high" DOC response to flow. Figure 13 and Table 4 show that, after excluding the June-October data, reasonable regressions could be found between DOC and flow.

Historic DOC was then associated with "low," "low-intermediate," "high-intermediate", or "high" response to flow (Figure 14). The "high" DOC response to flow tended to be associated with the first significant flow after many months of low flow. Categories of DOC response to flow displayed in Figure 14 were assigned to the planning period by considering similar patterns in flow. This allowed each monthly flow during the planning period to be associated with either 3.83 mg/L DOC (June - October), or with one of four regressions with DOC (Figure 15).

After assigning a DOC of 3.83 mg/L to each month from June though October, regressions were applied to average flows from other months to generate DOC. DOC derived from the regressions was limited to between 2.4 and 11.4 mg/L, the minimum and maximum values seen in the observed data. Figure 17 compares the historic Vernalis/Mossdale DOC to the DOC generated by this method. Figure 18 and Table 2 show the resulting generated DOC over the planning period. The average DOC generated at Vernalis by this process over the planning period was similar to the average observed DOC (Figure 19).

UVA at Vernalis was generated by applying a regression based on observed DOC and UVA at Vernalis (Figure 20) to the generated DOC (Table 3):

$$UVA = 0.037DOC - 0.035, R^2 = 0.9$$

Average generated UVA at Vernalis over the planning period was consistent with the average observed UVA at Vernalis (Figure 22).

Figure 11. Observed DOC and Flow at Vernalis

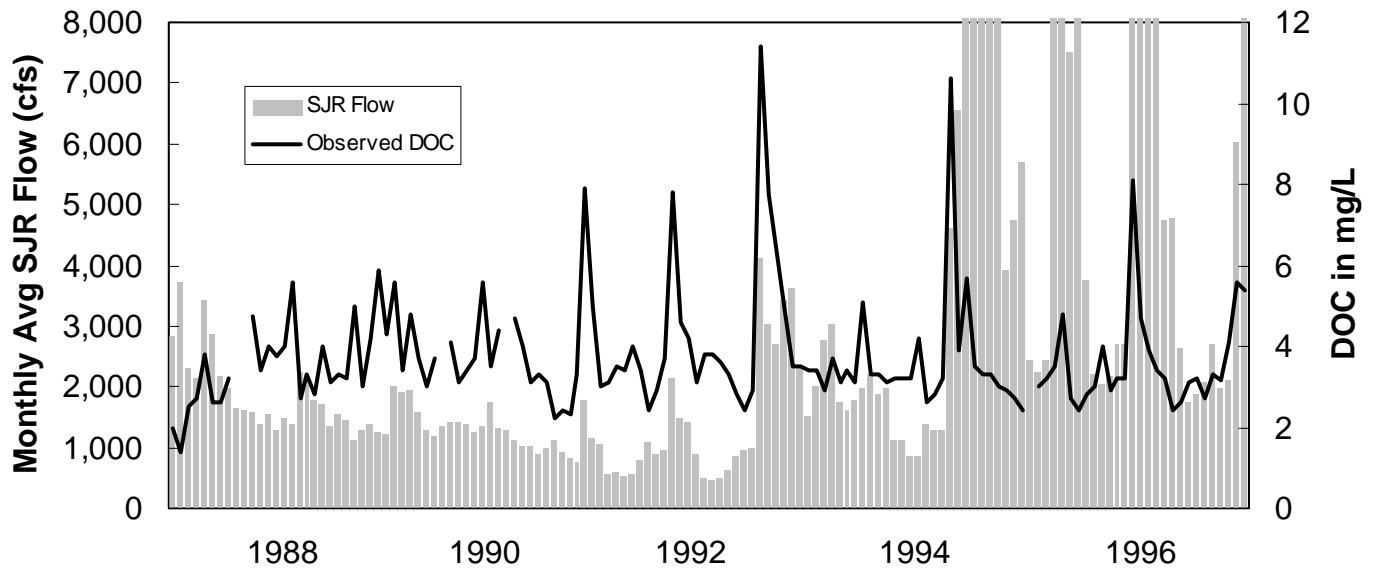


Figure 12. Observed DOC at Vernalis, 1987 - 1997
(grouped by month)

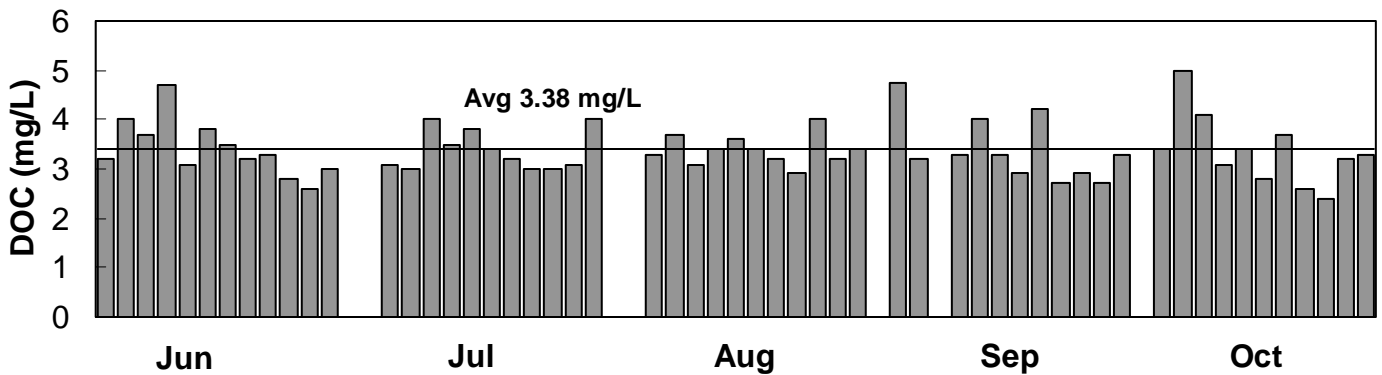


Figure 13. Observed DOC and Flow at Vernalis

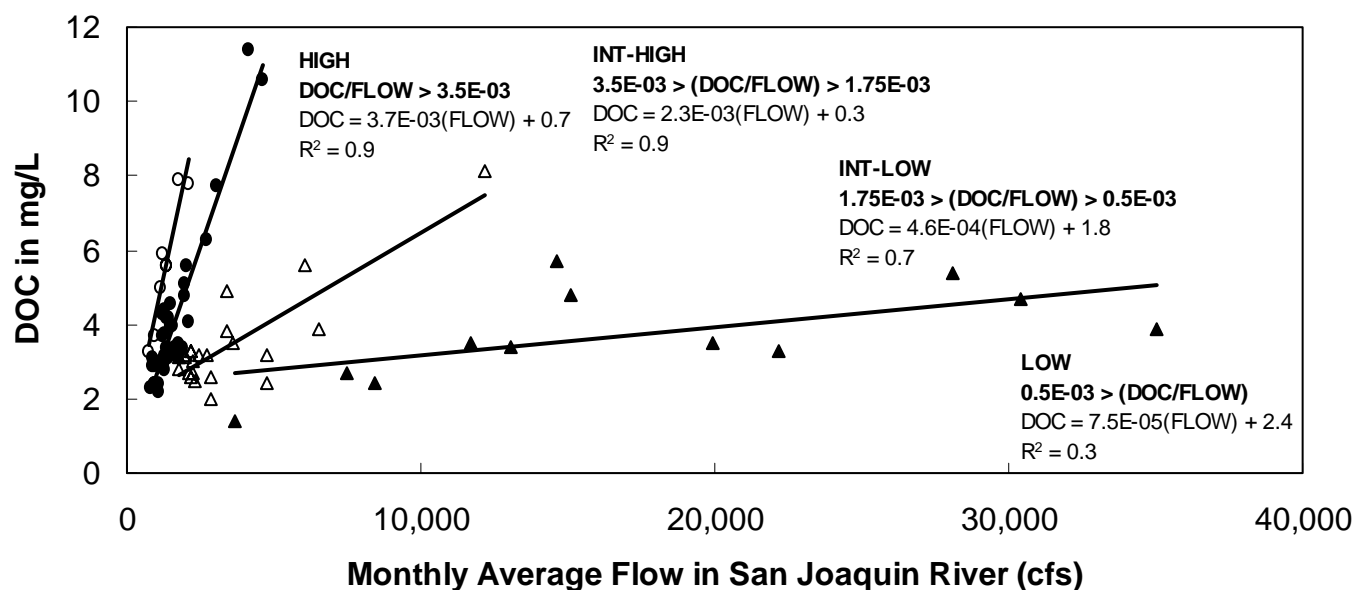


Table 4. Classification of DOC Response to Flow at Vernalis

DOC Response to Flow	Criteria	Regression Equation	R2
Low	$0.5\text{E-}03 > \text{DOC}/\text{FLOW}$	$\text{DOC} = 7.5\text{E-}05(\text{FLOW}) + 2.4$	0.3
Moderate-Low	$1.75\text{E-}03 > \text{DOC}/\text{FLOW} > 0.5\text{E-}03$	$\text{DOC} = 4.6\text{E-}04(\text{FLOW}) + 1.8$	0.7
Moderate-High	$20\text{E-}03 > \text{DOC}/\text{FLOW} > 1.75\text{E-}03$	$\text{DOC} = 2.3\text{E-}03(\text{FLOW}) + 0.3$	0.9
High	$\text{DOC}/\text{FLOW} > 20 \text{ E-}03$	$\text{DOC} = 3.7\text{E-}03(\text{FLOW}) + 0.7$	0.9

DOC: monthly dissolved organic carbon (mg/L)

FLOW: monthly average flow in San Joaquin River at Vernalis (cfs)

Figure 14. Historic SJR Flow at Vernalis Categorized by DOC Response to Flow

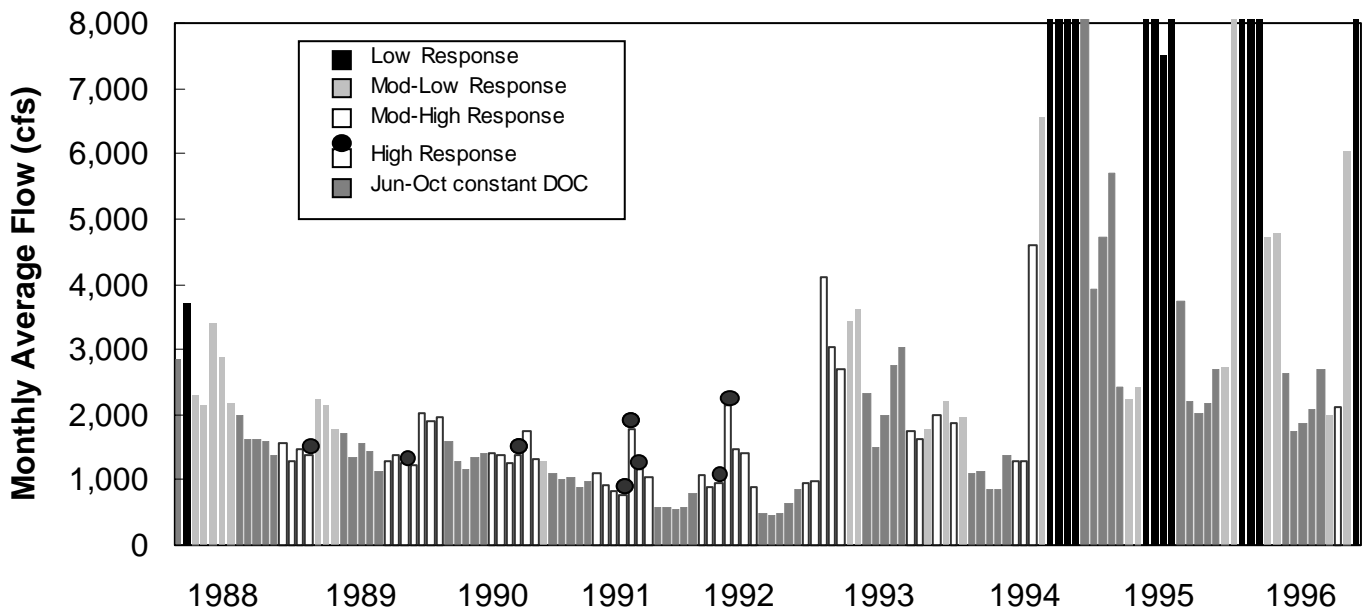


Figure 15. Assignment of DOC/Flow Relationship at Vernalis for Planning Period

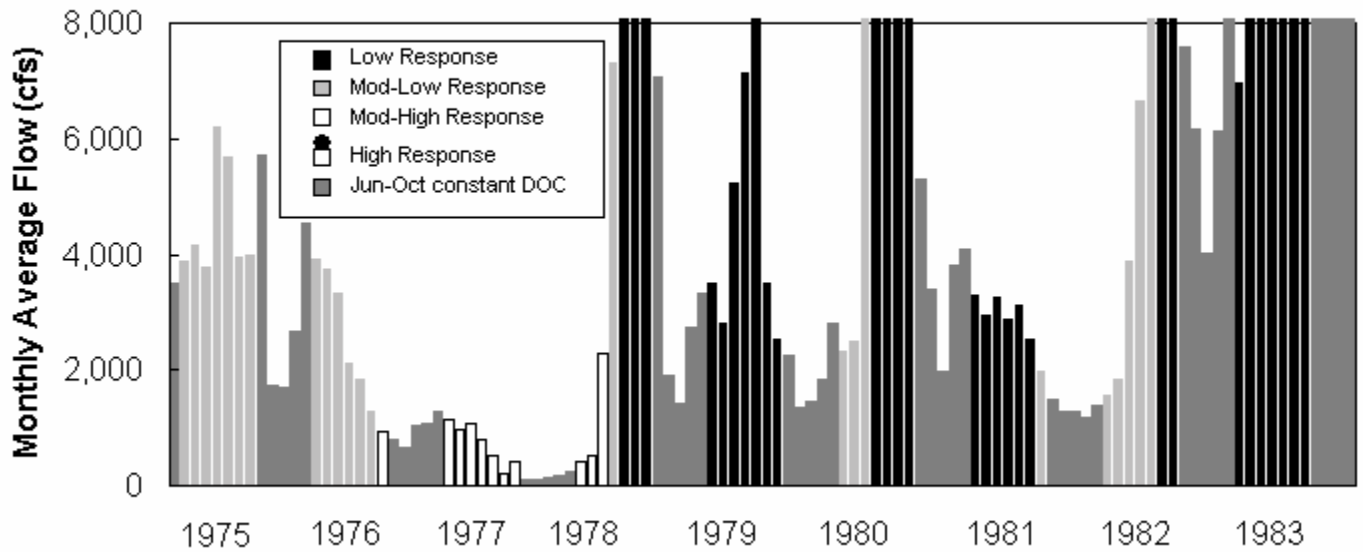


Figure 15. Assignment of DOC/Flow Relationship at Vernalis for Planning Period

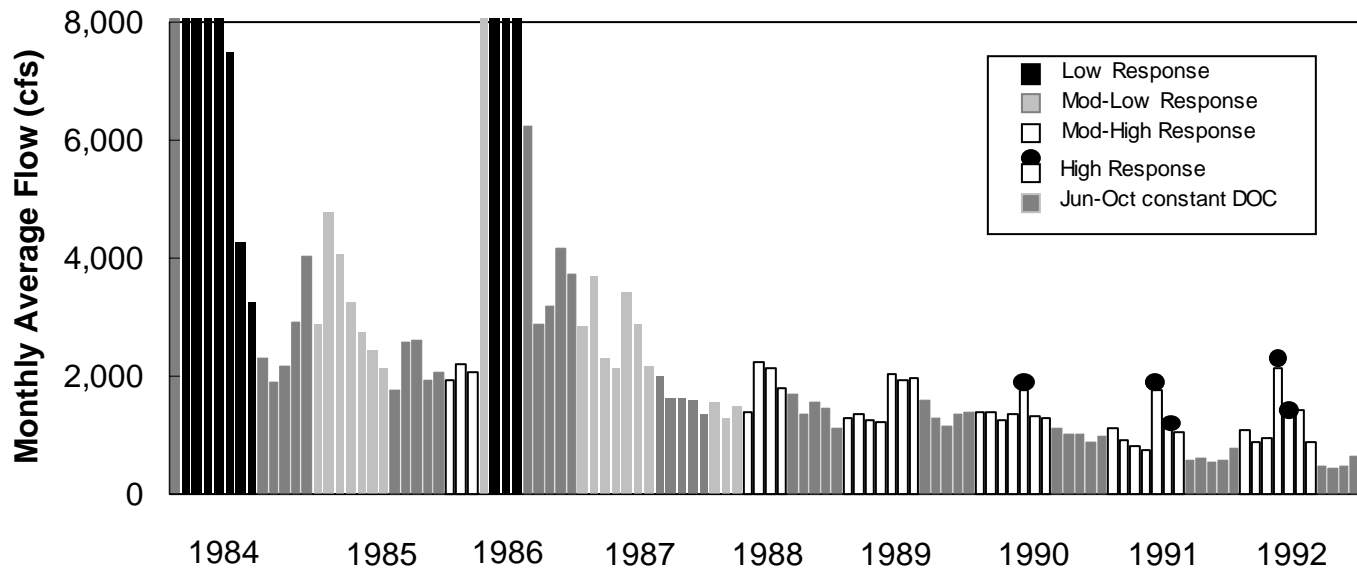


Figure 16. Observed and Generated DOC at Vernalis

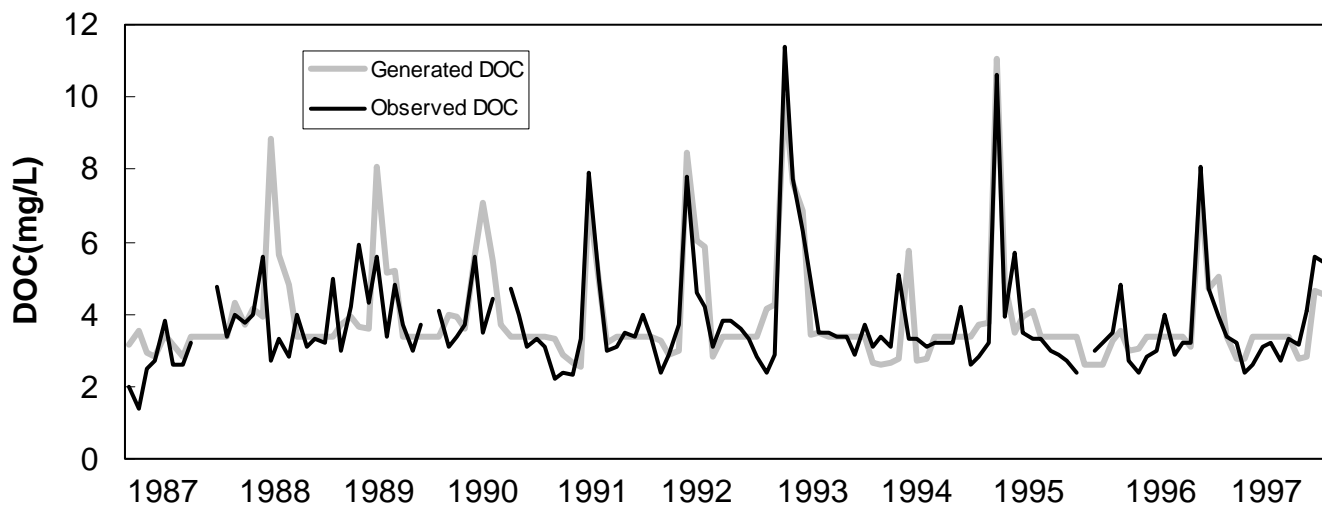


Figure 17. Generated DOC at Vernalis

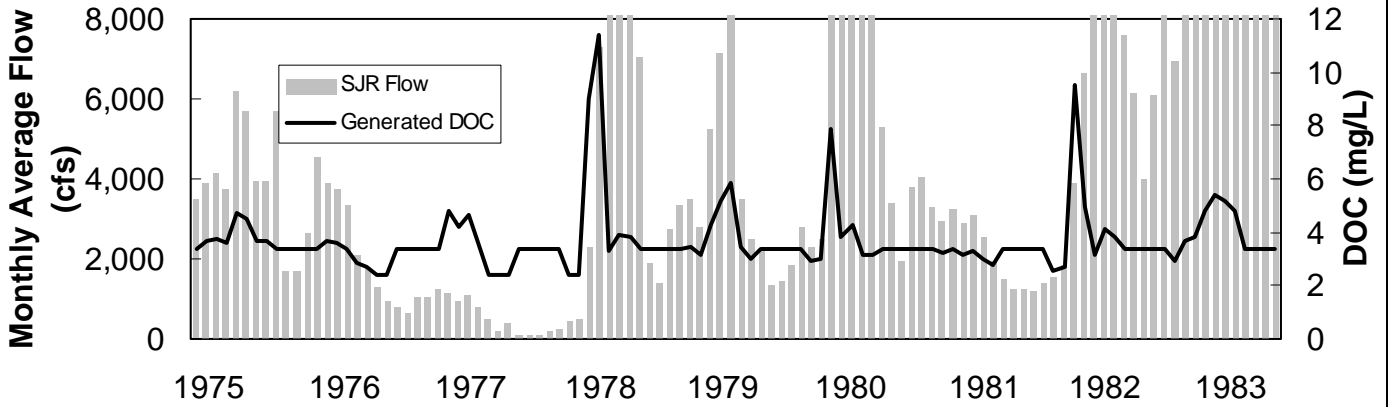


Figure 17. Generated DOC at Vernalis

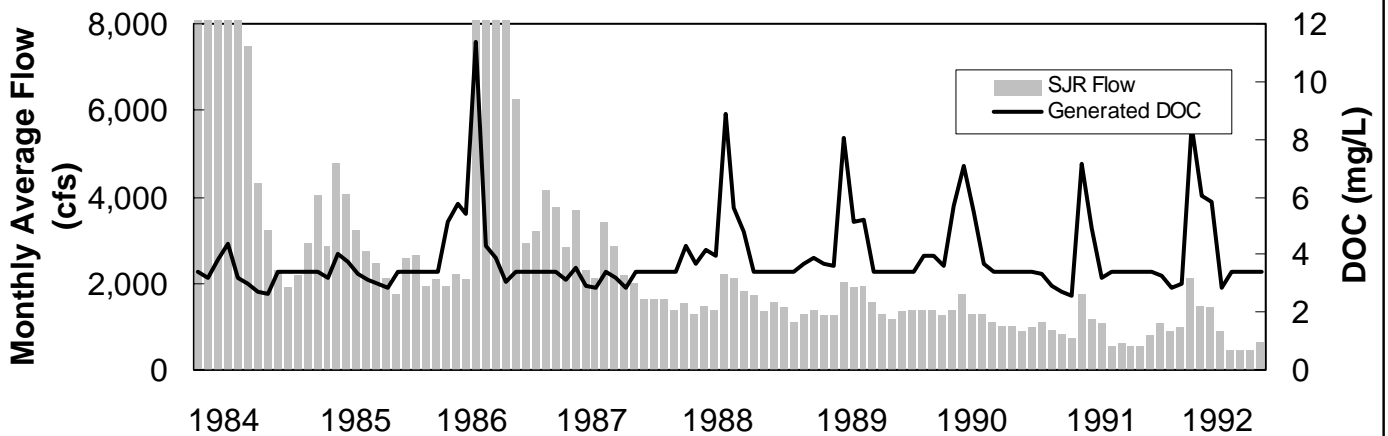


Table 5. Generated DOC at Vernalis (values in mg/L)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	3.38	3.64	3.76	3.58	4.71	4.47	3.67	3.68	3.38	3.38	3.38	3.38
1976	3.38	3.65	3.57	3.38	2.82	2.68	2.44	2.40	3.38	3.38	3.38	3.38
1977	3.38	4.83	4.20	4.66	3.56	2.40	2.40	2.40	3.38	3.38	3.38	3.38
1978	3.38	2.40	2.40	8.99	11.40	3.27	3.91	3.84	3.38	3.38	3.38	3.38
1979	3.38	3.46	3.14	4.26	5.14	5.84	3.46	3.01	3.38	3.38	3.38	3.38
1980	3.38	2.91	2.99	7.89	3.80	4.30	3.17	3.15	3.38	3.38	3.38	3.38
1981	3.38	3.35	3.20	3.34	3.17	3.28	3.01	2.75	3.38	3.38	3.38	3.38
1982	3.38	2.56	2.69	9.51	4.91	3.16	4.13	3.80	3.38	3.38	3.38	3.38
1983	3.38	2.93	3.64	3.84	4.78	5.41	5.14	4.79	3.38	3.38	3.38	3.38
1984	3.38	3.22	3.84	4.34	3.21	2.97	2.73	2.65	3.38	3.38	3.38	3.38
1985	3.38	3.16	4.05	3.72	3.34	3.11	2.97	2.82	3.38	3.38	3.38	3.38
1986	3.38	5.15	5.76	5.44	11.40	4.28	3.87	3.06	3.38	3.38	3.38	3.38
1987	3.38	3.15	3.55	2.90	2.83	3.42	3.16	2.85	3.38	3.38	3.38	3.38
1988	3.38	4.30	3.70	4.16	3.93	8.86	5.63	4.82	3.38	3.38	3.38	3.38
1989	3.38	3.69	3.91	3.65	3.60	8.06	5.12	5.19	3.38	3.38	3.38	3.38
1990	3.38	3.98	3.93	3.62	5.66	7.10	5.46	3.70	3.38	3.38	3.38	3.38
1991	3.38	3.34	2.90	2.67	2.54	7.17	4.94	3.19	3.38	3.38	3.38	3.38
Avg	3.38	3.51	3.60	4.70	4.75	4.69	3.84	3.42	3.38	3.38	3.38	3.38

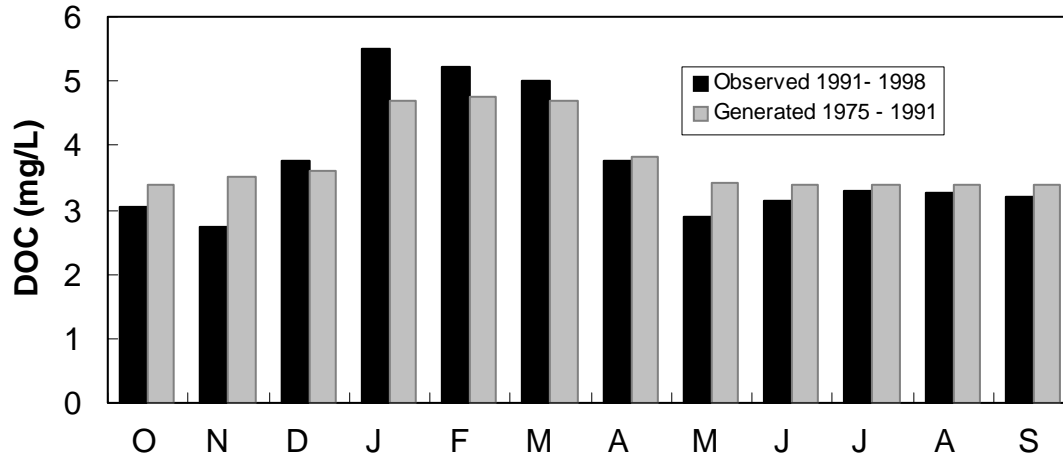
Figure 18. Monthly Average Observed and Generated DOC at Vernalis

Figure 19. Observed UVA vs Observed DOC at Vernalis/Mosssdale

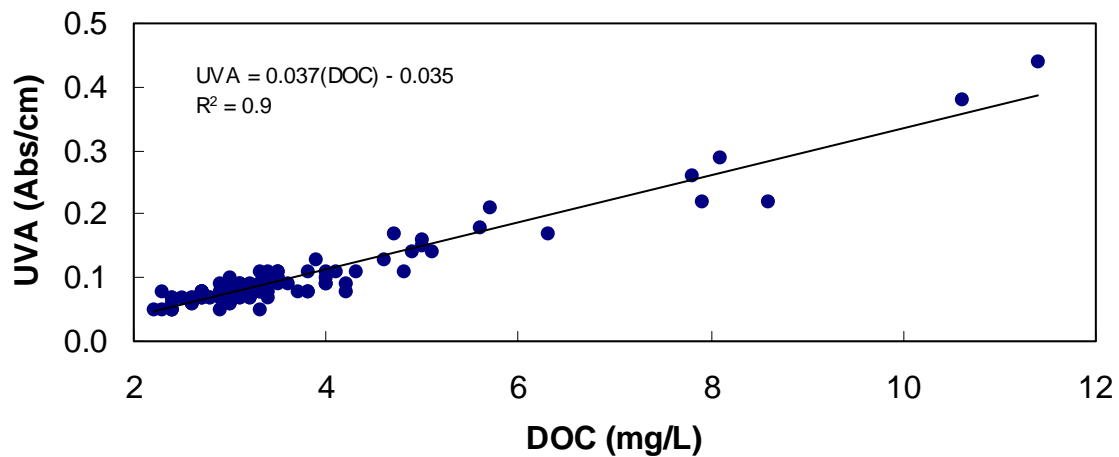
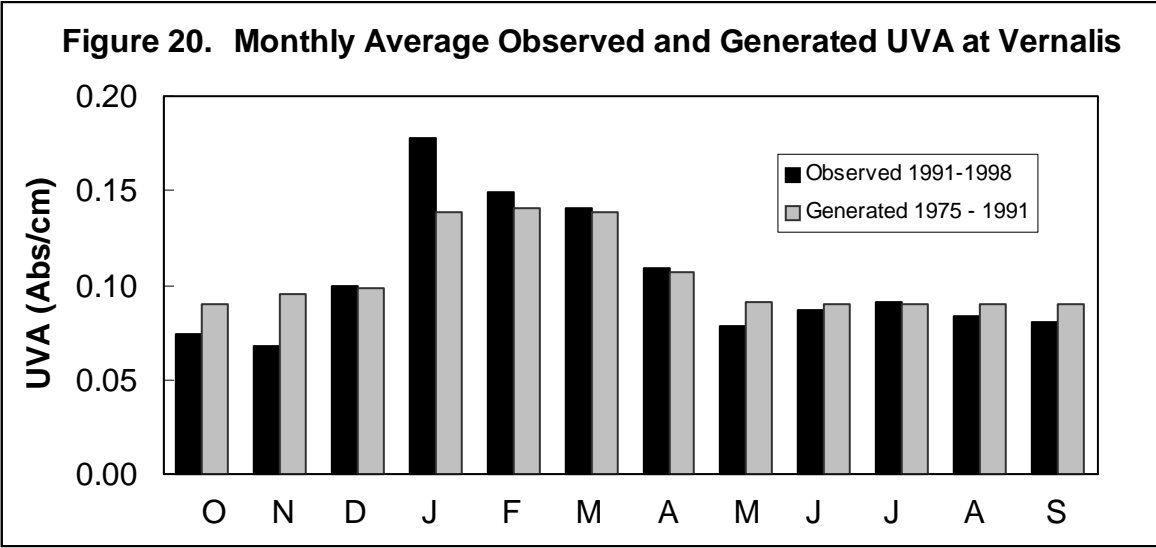


Table 6. Generated UVA at Vernalis (values in Abs/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	0.09	0.10	0.10	0.10	0.14	0.13	0.10	0.10	0.09	0.09	0.09	0.09
1976	0.09	0.10	0.10	0.09	0.07	0.06	0.06	0.05	0.09	0.09	0.09	0.09
1977	0.09	0.14	0.12	0.14	0.10	0.05	0.05	0.05	0.09	0.09	0.09	0.09
1978	0.09	0.05	0.05	0.30	0.39	0.09	0.11	0.11	0.09	0.09	0.09	0.09
1979	0.09	0.09	0.08	0.12	0.16	0.18	0.09	0.08	0.09	0.09	0.09	0.09
1980	0.09	0.07	0.08	0.26	0.11	0.12	0.08	0.08	0.09	0.09	0.09	0.09
1981	0.09	0.09	0.08	0.09	0.08	0.09	0.08	0.07	0.09	0.09	0.09	0.09
1982	0.09	0.06	0.06	0.32	0.15	0.08	0.12	0.11	0.09	0.09	0.09	0.09
1983	0.09	0.07	0.10	0.11	0.14	0.16	0.15	0.14	0.09	0.09	0.09	0.09
1984	0.09	0.08	0.11	0.13	0.08	0.07	0.07	0.06	0.09	0.09	0.09	0.09
1985	0.09	0.08	0.11	0.10	0.09	0.08	0.07	0.07	0.09	0.09	0.09	0.09
1986	0.09	0.16	0.18	0.17	0.39	0.12	0.11	0.08	0.09	0.09	0.09	0.09
1987	0.09	0.08	0.10	0.07	0.07	0.09	0.08	0.07	0.09	0.09	0.09	0.09
1988	0.09	0.12	0.10	0.12	0.11	0.29	0.17	0.14	0.09	0.09	0.09	0.09
1989	0.09	0.10	0.11	0.10	0.10	0.26	0.15	0.16	0.09	0.09	0.09	0.09
1990	0.09	0.11	0.11	0.10	0.17	0.23	0.17	0.10	0.09	0.09	0.09	0.09
1991	0.09	0.09	0.07	0.06	0.06	0.23	0.15	0.08	0.09	0.09	0.09	0.09
Avg	0.09	0.09	0.10	0.14	0.14	0.14	0.11	0.09	0.09	0.09	0.09	0.09



Mokelumne River DOC and UVA

Due to insufficient data, observed DOC from the American River was used to generate DOC for the Mokelumne River. Figure 21 shows historic DOC and flow in the American River. DOC from June through October was averaged to yield a single value of 1.66 mg/L to approximate monthly DOC each year during this interval for the planning period (Figure 22). Unlike Greens Landing and Vernalis, DOC in the American River in other months exhibited no apparent pattern with flows and therefore was simply averaged to yield two alternative values of DOC (Figure 23):

Low DOC = 1.74 mg/L

High DOC = 3.95 mg/L

These DOC values were then associated with flow in the Mokelumne River over the planning period, with 4.00 mg/L assigned to the first higher flows in the winter, 1.66 mg/L to June through October, and 1.74 mg/L to all other months (Figure 24, Table 7). The average DOC generated in the Mokelumne River by this process over the planning period was similar to the average observed DOC (Figure 25).

UVA in the Mokelumne River was generated by applying a regression based on historic DOC and UVA to the generated DOC (Figure 26, Table 3). Average generated UVA in the Mokelumne River over the planning period was consistent with the average observed UVA (Figure 27).

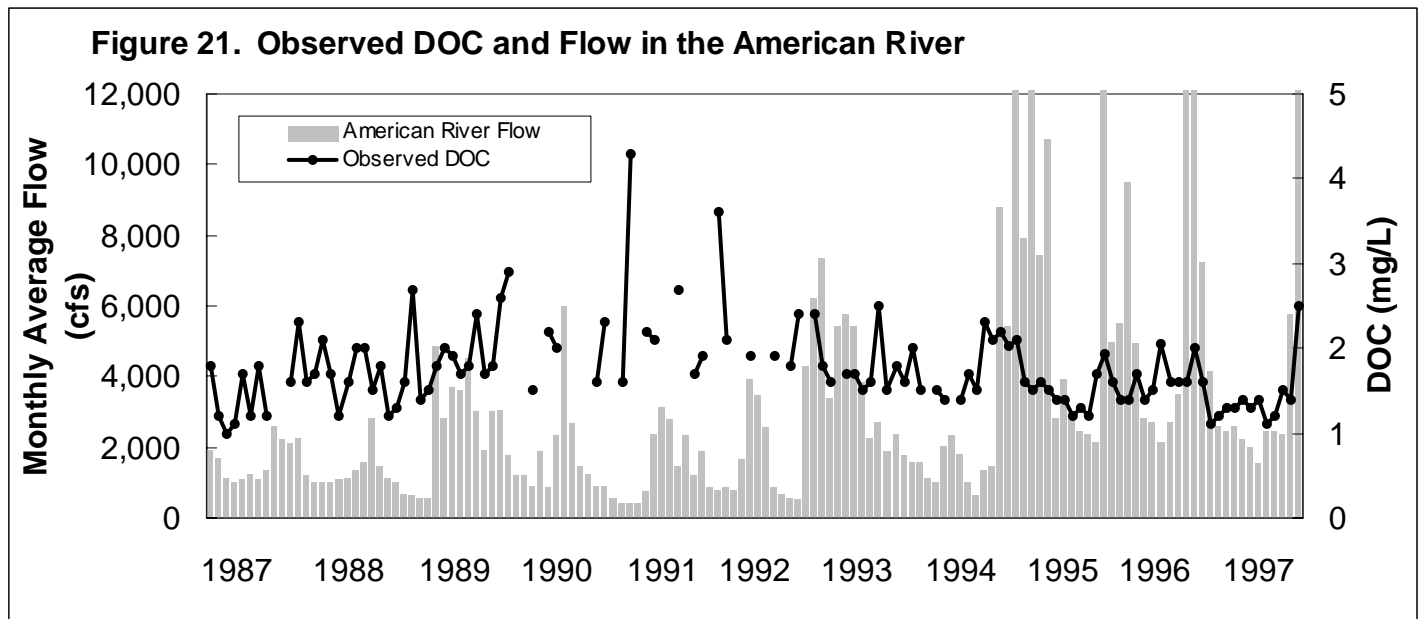


Figure 22. Observed DOC in American River, 1987 - 1997
(grouped by month)

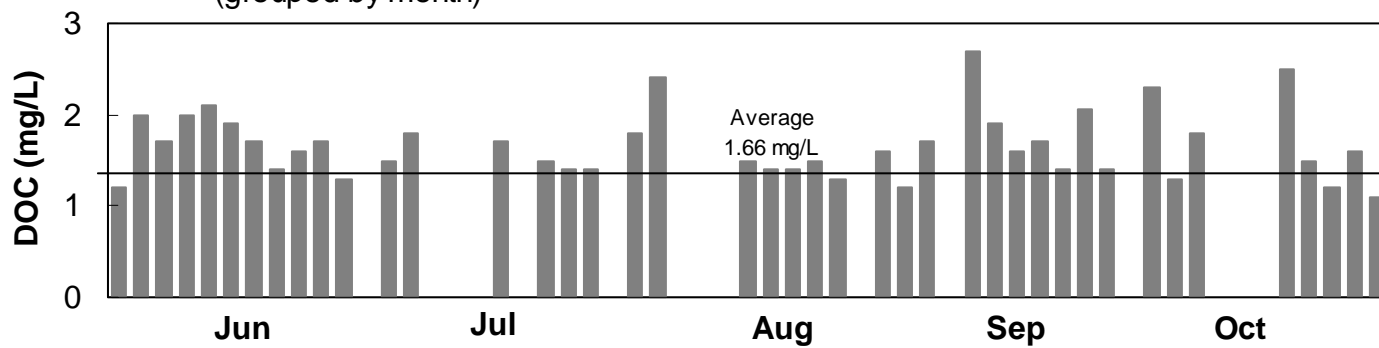


Figure 23. Flow and Observed DOC in the American River
(June - October Values Removed)

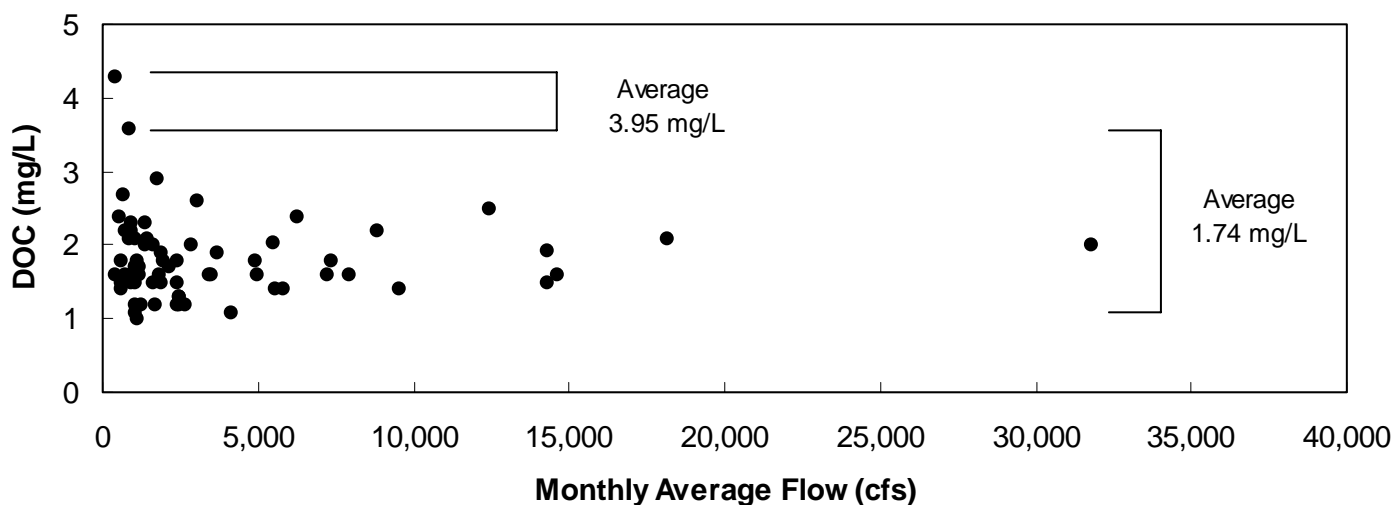


Figure 24. Generated DOC in Mokelumne River

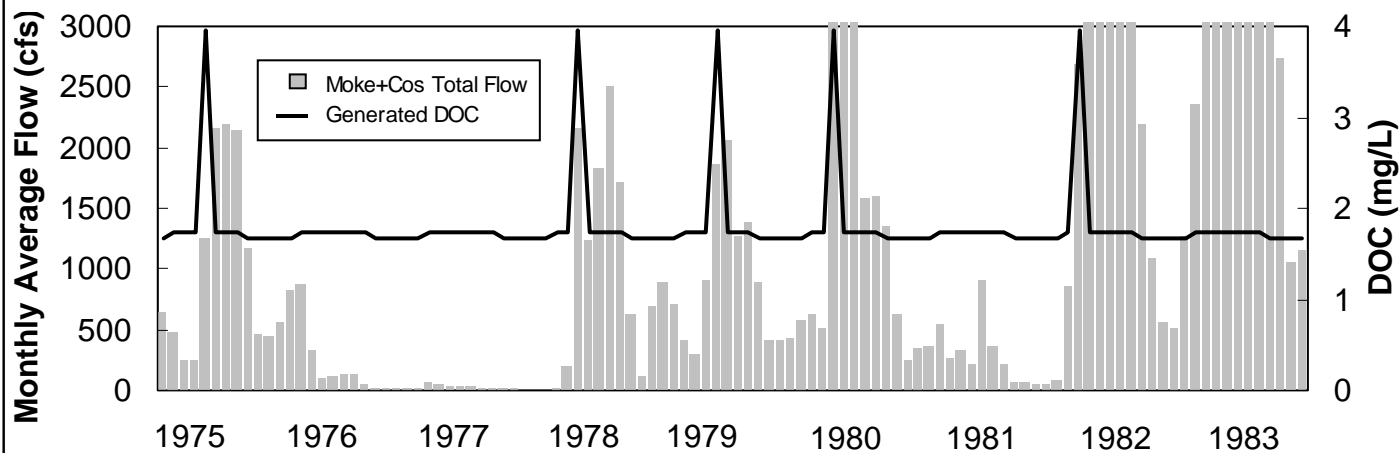


Figure 24. Generated DOC in Mokelumne River

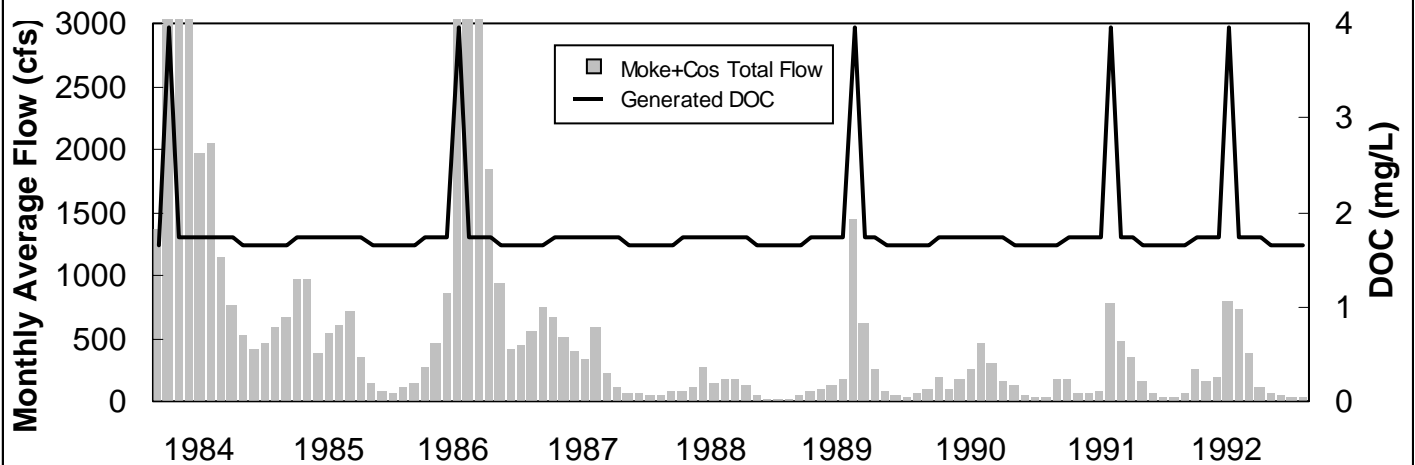


Table 7. Generated DOC in Mokelumne River (values in mg/L)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	1.66	1.74	1.74	1.74	3.95	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1976	1.66	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1977	1.66	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1978	1.66	1.74	1.74	3.95	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1979	1.66	1.74	1.74	1.74	3.95	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1980	1.66	1.74	1.74	3.95	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1981	1.66	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1982	1.66	1.74	3.95	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1983	1.66	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1984	1.66	3.95	1.74	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1985	1.66	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1986	1.66	1.74	1.74	1.74	3.95	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1987	1.66	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1988	1.66	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1989	1.66	1.74	1.74	1.74	1.74	3.95	1.74	1.74	1.66	1.66	1.66	1.66
1990	1.66	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.66	1.66	1.66	1.66
1991	1.66	1.74	1.74	1.74	1.74	3.95	1.74	1.74	1.66	1.66	1.66	1.66
Avg	1.66	1.87	1.87	2.00	2.13	2.00	1.74	1.74	1.66	1.66	1.66	1.66

Figure 25. Monthly Average Observed and Generated DOC in Mokelumne River

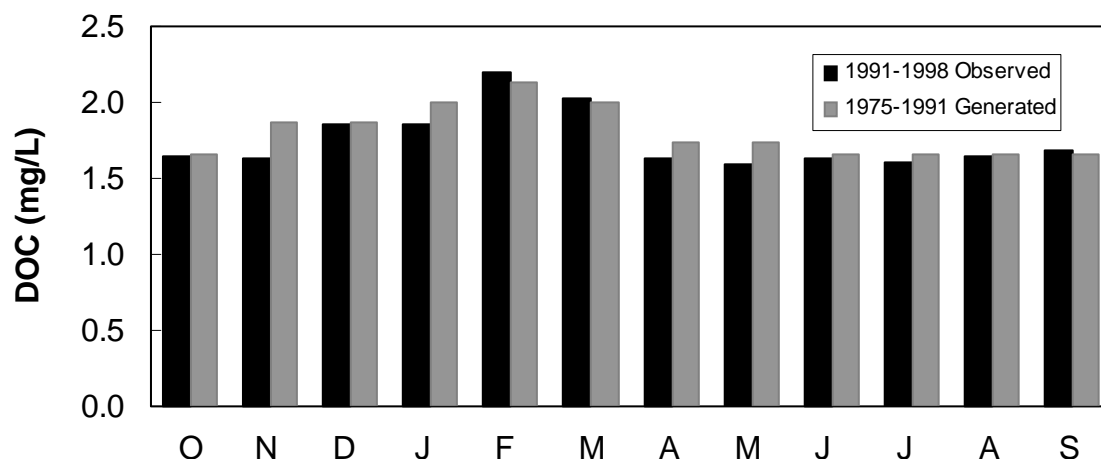


Figure 26. Observed UVA vs Observed DOC in Mokelumne River

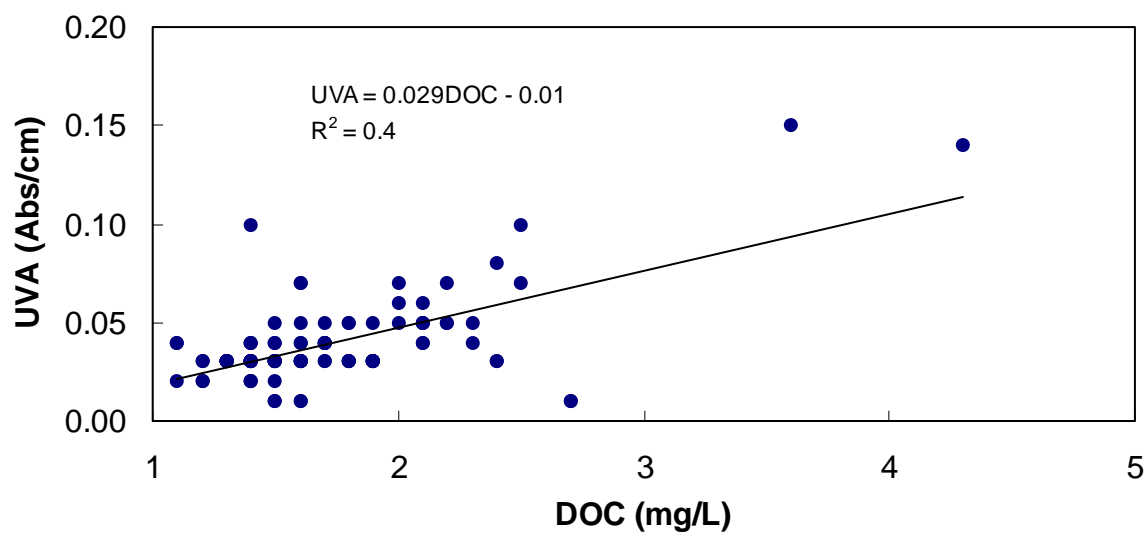


Table 8. Generated UVA in Mokelumne River (values in Abs/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	0.04	0.04	0.04	0.04	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1976	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1977	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1978	0.04	0.04	0.04	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1979	0.04	0.04	0.04	0.04	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1980	0.04	0.04	0.04	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1981	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1982	0.04	0.04	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1983	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1984	0.04	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1985	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1986	0.04	0.04	0.04	0.04	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1987	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1988	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1989	0.04	0.04	0.04	0.04	0.04	0.10	0.04	0.04	0.04	0.04	0.04	0.04
1990	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1991	0.04	0.04	0.04	0.04	0.04	0.10	0.04	0.04	0.04	0.04	0.04	0.04
Avg	0.04	0.04	0.04	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04

